a guide to the geology of the Cave in Rock - Rosiclare area

David L. Reinertsen

Field Trip 1982 D
November 6, 1982
Department of Energy and Natural Resources
State Geological Survey Division
Champaign, IL 61820

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the geologic framework

The Cave In Rock-Rosiclare area is in the eastern part of the Shawnee Hills, one of the most scenic areas in Illinois. This rugged terrain was produced primarily by differential erosion of upper Mississippian and lower Pennsylvanian sedimentary strata. These strata consist of regular alternations of sandstone, limestone, and shale. Ridges are underlain by resistant rocks (usually the sandstones), and valleys are underlain by the relatively softer limestones and shales. Numerous faults cut the strata and interrupt the regularity of the ridges and valleys.

The field trip area is underlain by approximately 10,000 feet of Paleozoic sedimentary rocks, ranging in age from Late Cambrian (about 500 million years old) to early Pennsylvanian (about 300 million years old). These rocks, which rest upon a basement complex of Precambrian granitic rocks more than a billion years old, were deposited in the ancient, shallow seas that periodically covered the Midwest during the Paleozoic Era. The field trip area lies near the southern margin of the Illinois Basin, a large elliptical depression—now filled with Paleozoic sediments—that covers most of Illinois, northwestern Kentucky, and southwestern Indiana (see attached Geologic Map of Illinois). About 3000 feet of these sedimentary rocks, ranging in age from early Devonian (about 400 million years old) to early Pennsylvanian is exposed. Exposures of the Devonian rocks are restricted to a small area on Hicks Dome, a relatively localized uplift in the extreme northwest part of the area.

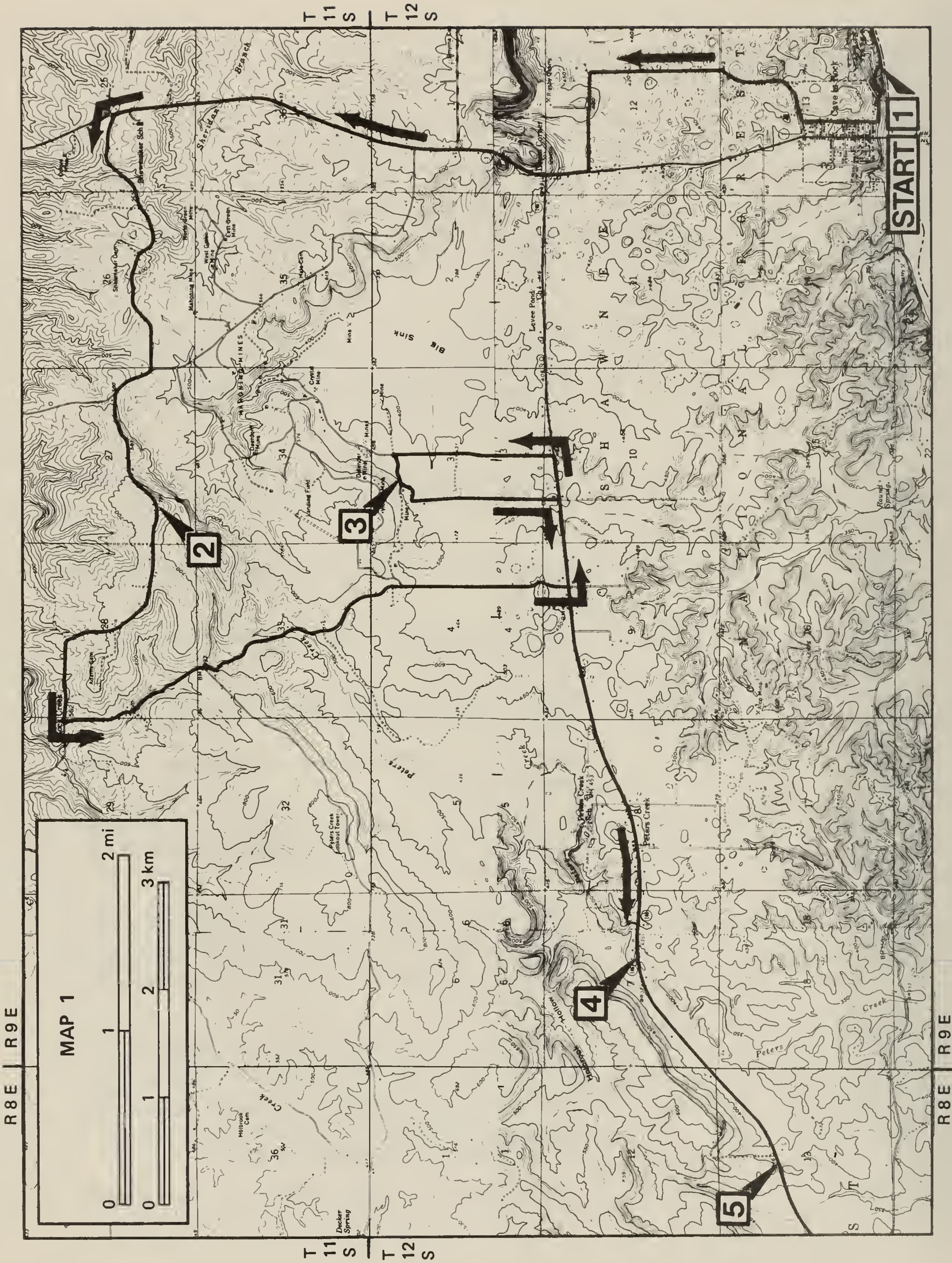
Regionally, the bedrock strata are tilted gently toward the northeast, although many anomalous local dips occur because of the great number of faults in the area. The major structural feature is the Rock Creek Graben, an elongate downfaulted block that extends diagonally across the area from northeast to southwest. Southeast of the Rock Creek Graben the strata are cut by few faults; complexly faulted strata are found within and to the northwest of the graben. A large area underlain by these relatively unfaulted rocks occurs principally in the vicinity of Cave In Rock; here, the terrain is markedly less rugged than elsewhere in the field trip area. A rolling landscape with numerous sinkholes, characteristic of karst topography, is developed upon the thick middle Mississippian limestones.

Igneous peridotite dikes and explosion breccias, apparently related in origin, also occur in the Cave In Rock-Rosiclare area. These features are believed to have formed during a period of intense crustal deformation when the strata were also broken by the numerous faults. Radioactive dating of the igneous dikes has indicated a possible Permian age for their emplacement (about 165 million years ago).

The field trip area lies within the heart of the Illinois-Kentucky Fluorspar District. With a history of fluorspar mining that dates from 1842, the Illinois portion of the district is still rich in minable fluorspar, accounting for more than three fourths of the fluorspar produced and shipped in this country in 1980. Valuable accessory minerals also mined are galena, sphalerite, and barite, the principal sources of lead, zinc, and barium, respectively. Another mineral resource of considerable importance to the economy of this area is limestone for use as agricultural lime, roadstone, riprap, and in the manufacture of cement. More than 2.3 million tons of stone with a value of more than $5.8 million were produced in Hardin County in 1980. In addition, minor amounts of silver, gemstones, and germanium were produced.

guide to the route

Miles to next point	Miles to starting point	
		Start of Cave in Rock—Rosiclare Geological Science Field Trip. Assemble at the Picnic Shelter overlooking the Ohio River above and just east of the cave.
		STOP 1. VISIT CAVE AND DISCUSS ITS ORIGIN AND THE DEVELOPMENT OF KARST TOPOGRAPHY.
0.0	0.0	Leave stop 1. HEAD WEST (one-way road down the hill).
0.05	0.05	CAUTION; pathway to cave on left. CONTINUE AHEAD (west).
0.1	0.15	STOP (1-way); T-road intersection. TURN LEFT (west) and enter town of Cave in Rock.
0.15-	0.3-	TURN RIGHT (north) on Broad Street and continue ahead (north).
0.45	0.75-	STOP (1-way); T-road intersection. TURN RIGHT (east) in front of the abandoned Cave in Rock High School.
0.2+	0.95-	Leave Cave in Rock. Notice sinkholes on both sides of the road. Trees are growing in the bottom of many of these sinkholes. The homes and the road here are built on ridges between the sinkholes.
0.25+	1.2	The bottom of the sinkhole to the left is plugged up by sediments and holds water.
0.2	1.4	Y-intersection; BEAR LEFT (north). Power substation to the left. Some of the sinkholes here are broad and flat-bottomed.
0.05	1.45	To the right is another water-filled sinkhole.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Cave in Rock
Sheridan
Peters Creek
Big Sink
Levee Pond
Holbrook Cem
Docker Spring
Round Spring

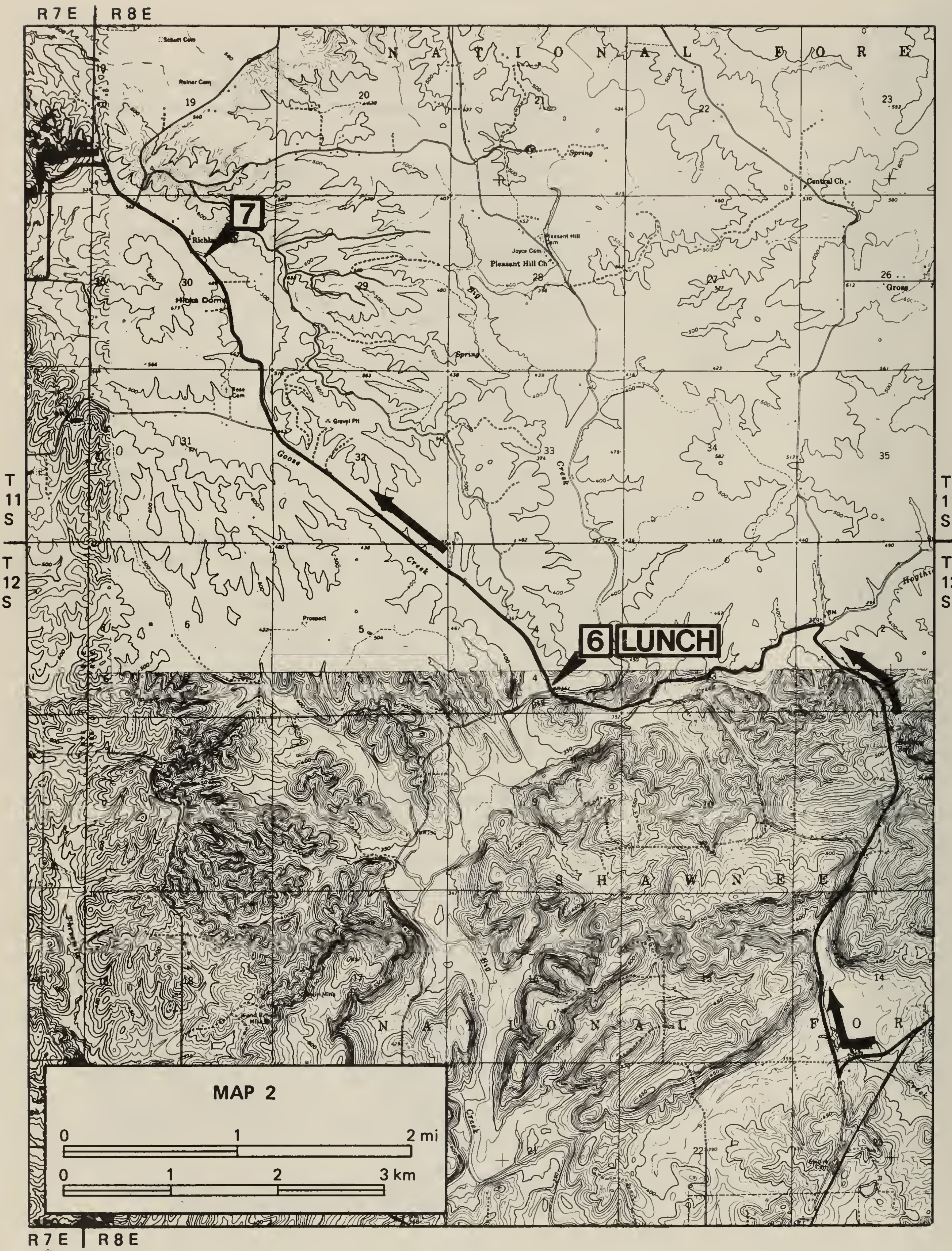
Miles to next point	Miles to starting point	
0.2	1.65	View ahead (north) of the Rigsby and Barnard Quarry. The Fredonia Limestone, the lowermost member of the Mississippian Ste. Genevieve Limestone Formation, is quarried here.
0.3	1.95	To the left is the Hardin County Golf Course.
0.2	2.15	TURN LEFT (west).
0.15	2.3	At the crest of the small hill, the view south beyond the golf course shows well the very uneven topography produced by many sinkholes. CONTINUE AHEAD (west).
0.1	2.4	To the right is a closer view of the Mississippian upper Valmeyeran strata rocks exposed in the Rigsby and Barnard Quarry. CONTINUE AHEAD (west).
0.35-	2.75-	STOP (1-way); T-road intersection with State Route (SR) #1. TURN RIGHT (north).
0.25	3.0-	CAUTION; T-road from left (SR-146). CONTINUE AHEAD (north) on SR #1.
0.1+	3.1	Denny and Simpson Stone Company to the left also quarries the Mississippian Fredonia Limestone.
0.35	3.45	To the left are several good views of the cuestas in the distance on the horizon.
1.45	4.9	Mississippian (Chesterian) Cypress Sandstone exposed in the roadcut. CONTINUE AHEAD (north).
0.4	5.3	Shale, limestone, and sandstone of the Mississippian (Chesterian) Golconda Group exposed on the roadcut. CONTINUE AHEAD (north).
0.15	5.45	Illinois Department of Corrections Vienna Correctional Center facility to the left. CONTINUE AHEAD (north) and prepare to turn left.
0.15-	5.6-	TURN LEFT (northwest) at T-road intersection.
0.05+	5.65	To the right (northwest) is a glimpse of the Oxford Mine hoist. CONTINUE AHEAD (westerly).
0.5	6.15	Chesterian Hardinsburg Sandstone exposed in the ditch on the right.

Miles to next point	Miles to starting point	
0.15	6.3	To the right (¼ mile) is the Ozark-Mahoning Oxford No. 7 fluorspar Mine.
0.25	6.55	Y-intersection; BEAR LEFT (westerly).
0.4	6.95	To the left is one of the Ozark-Mahoning mines.
0.35-	7.3-	CAUTION; T-road intersection. TURN RIGHT (north).
0.25	7.55-	CAUTION; Y-intersection. BEAR LEFT (northwest).
0.45+	8.0	Thick-bedded sandstone of the Pennsylvanian Caseyville Formation crops out in the road.
0.25	8.25	STOP 2. THE RADIO TOWER SITE OF THE FORMER MINERVA OIL COMPANY. NOTICE THE PANORAMIC VIEW AT THE CREST OF THE HILL.
0.0	8.25	Leave Stop 2 and CONTINUE AHEAD (west). The route goes west and then north.
1.55+	9.8+	T-road from left at hamlet of Rock Creek; TURN SHARP LEFT (southerly).
0.4+	10.2+	CAUTION; concrete ford. CONTINUE AHEAD.
0.25	10.45+	CAUTION; concrete ford. CONTINUE AHEAD.
0.25-	10.7+	Y-intersection; BEAR LEFT and descend the hill past exposure of sandstone of the Pennsylvanian Caseyville Formation.
0.25	10.95+	To the left is a good example of what happens when there are no convenient county landfill sites—any creek bank or steep embankment will suffice for trash and garbage disposal.
0.3+	11.25+	JOG LEFT across the Peters Creek bridge and then TURN RIGHT.
0.25	11.5+	To the left is another trash dumping site.
0.05	11.55+	At the start of the curve, sandstone blocks are exposed on the left. These are probably Mississippian Bethel Sandstone pieces that are very near the Peters Creek Fault System.
0.5	12.05+	CAUTION; entrance to the Hastie Mining Company on the left. CONTINUE AHEAD (south).

Miles to next point	Miles to starting point	
0.8	12.85+	The road curves around the deeper part of a large water-filled sink. Several fairly large sinkholes in this area are filled with water.
0.15+	13.0+	STOP (2-way); crossroad (SR 146). USE EXTREME CAUTION. TURN LEFT (east). Visibility to the left is poor.
0.6	13.6+	Prepare to turn left. View ahead of the cuesta and Rigsby and Barnard Quarry face.
0.15+	13.8-	CAUTION; visibility ahead is poor. TURN LEFT (north). This road, which is very rough and uneven, is the old mine road to the Crystal Mine of the former Minerva Mining Company, now owned by Inverness Mining Company.
0.65	14.45-	To the left is a mine dump—possibly an old mine shaft or air shaft site.
0.1-	14.55-	The lowest part of the road here lies across the westernmost tip of Big Sink.
0.2+	14.75	CAUTION; Y-intersection from left. TURN LEFT (westerly). This private mine road is owned by the Hastie Mining Company. Continue to bear left; do NOT go up the road to the right. CAUTION; BEAR LEFT and ascend the hill around the spoil pile.
0.1	14.85	Immediately in front of you is a large spoil pile from the stripping operation that the Hastie Mining Company is carrying on in this area. Do NOT climb on this pile as there are a number of large slabs that could easily slide down the slope. Park on the far LEFT side of the road.
0.05+	14.9+	STOP 3. FLUORITE COLLECTING IN THE AREA OF THE LONG-ABANDONED BENZON MINE THAT HAS BEEN STRIPPED BY HASTIE MINING COMPANY. YOU MUST HAVE PERMISSION TO USE THIS ROAD AND ENTER THIS PROPERTY. DO NOT UNDER ANY CONDITIONS GO BACK IN ANY OF THE OLD MINE OPENINGS OR CAVERNS HERE.
0.0+	14.9+	Leave Stop 3. USE EXTREME CAUTION; BEAR LEFT (southwesterly) down the slope on the old road.

Miles to next point	Miles to starting point	
0.1+	15.0+	These abandoned buildings are part of the processing plant of the Benzon Mine.
0.05	15.05+	TURN LEFT (south). Just beyond the turn is an area where horsetail (Equisetum)—a relative of some of the early Pennsylvanian scouring rushes—grows thickly. CONTINUE AHEAD (south) on the narrow lane.
0.35	15.4+	A large water-filled sinkhole to the right.
0.5+	15.9+	STOP (2-way); crossroads. TURN RIGHT (west) on SR 146.
2.55	18.45+	The route descends into the valley of Peters Creek. Prepare to stop.
0.2	18.65+	STOP 4. DISCUSSION OF THE PETERS CREEK FAULT SYSTEM. CHESTERIAN (UPPER MISSISSIPPIAN) BETHEL SANDSTONE AND DOWNEYS BLUFF LIMESTONE IN THE ROADCUT. PARK WELL OFF THE ROAD ON THE RIGHT AND LOOK OUT FOR TRAFFIC. DO NOT BLOCK THE DRIVEWAYS OR STAND IN THE HIGHWAY.
0.0	18.65+	Leave Stop 4. CONTINUE AHEAD (west).
0.15-	18.8+	Cross Peters Creek.
1.3	20.1+	STOP 5. VALMEYERAN (MIDDLE MISSISSIPPIAN) STE. GENEVIEVE AND ST. LOUIS LIMESTONES IN THE ROADCUT.
0.0	20.1+	Leave Stop 5. CONTINUE AHEAD (west).
0.7	20.8+	T-road from left to Tower Rock Recreation Area along the Ohio River. CONTINUE AHEAD (west) and prepare to turn right.
0.25+	21.05+	TURN RIGHT (west) in front of the Hardin County K-12 School and then BEAR LEFT (southwest) on the blacktop.
0.35	21.4+	Cross Hosick Creek and prepare to turn right.
0.2-	21.6+	CAUTION: angle-road intersection from right on far side (west) of left curve on blacktop. TURN HARD RIGHT (north) on blacktop angle road.

Miles to next point	Miles to starting point	
0.5-	22.1	Renault Limestone exposed in roadcut on left (west) side of road.
0.65	22.75	Massive Chesterian Hardinsburg Sandstone on left side of road.
0.15	22.9	Exposure of Chesterian Tar Springs Sandstone and underlying shale to the left.
0.1-	23.0-	Angle road from left. CONTINUE STRAIGHT (northeasterly) on the blacktop.
0.1	23.1-	Thick exposure of Tar Springs Sandstone on the west side of the roadcut. The sandstone is noticeably crossbedded.
0.15+	23.25	To the left in the ditch and in the low bank are exposures of fossiliferous Chesterian Menard Limestone.
0.1	23.35	To the left are silty shale and sandstone of the Chesterian Palestine Sandstone Formation.
0.4-	23.75	Red and green shale of the Chesterian Degonia Sandstone Formation are exposed in the left roadcut. This shale is overlain by the Chesterian Kinkaid Formation. Capping the hill to the left (west) of this exposure is Pennsylvanian Caseyville Sandstone. The rocks are shattered here, indicating close proximity to a fault.
0.35	24.1-	CAUTION; end of blacktop road and start of gravel road.
0.25+	24.35	St. Louis Limestone exposed in roadside quarry on the right. The strata dip down about 7 degrees toward the northwest.
0.1	24.45	CAUTION; narrow bridge across Hogthief Creek.
0.1	24.55	CAUTION; crossroads. TURN LEFT (westerly). NOTE: the road to the right leads to a monument approximately 0.6 miles from this intersection. The monument is located in the weeds on the left (northwest) side of the road. The inscription "Martha B. F." is engraved on the stone and probably refers to Martha Furnace, located nearby.
0.05	24.6	To the left is a U.S. Forest Service experimental plantation of black walnut trees.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Reiner Cem
Hicks Dome
Rose Cem
Gravel Pit
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Spring
Goose Creek
Big Creek
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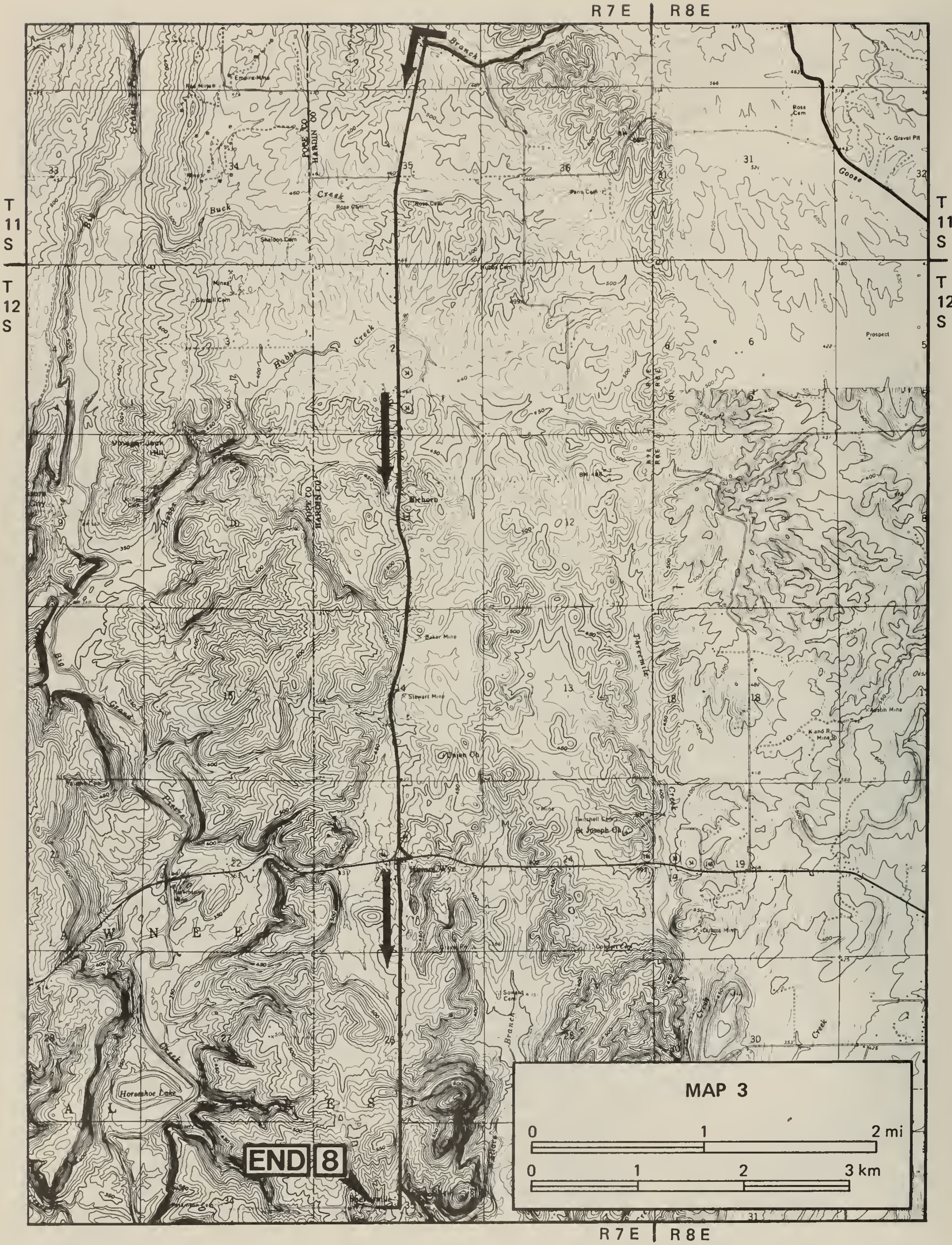
Miles to next point	Miles to starting point	
0.4-	25.0-	St. Louis Limestone exposed in roadcut to right.
0.8	25.8-	Y-intersection; BEAR RIGHT (westerly) toward Illinois Furnace.
0.35	26.15-	T-road from right; BEAR LEFT (westerly) toward Illinois Furnace. Two faults cross the route between this location and Illinois Furnace a little more than ¼ mile west northwest of here.
0.1+	26.25-	St. Louis Limestone is exposed in the roadcut to the left. Some Ste. Genevieve Limestone may be exposed on the east (left) end of the exposure along a fault.
0.1+	26.35	Cross Big Creek.
0.05-	26.4-	T-road from left; CONTINUE AHEAD (northwest).
0.05	26.45-	TURN RIGHT (northeast) into the Illinois Iron Furnace parking area and park.
		STOP 6. LUNCH AND DISCUSSION ABOUT EARLY PRODUCTION OF PIG IRON IN ILLINOIS.
0.0	26.45-	Leave Stop 6. TURN RIGHT (northwesterly).
0.45+	26.9-	T-road from right; CONTINUE AHEAD (northwest).
1.3+	28.2	T-road from right; CONTINUE AHEAD (northwest). Road appears to be used infrequently.
0.15-	28.35-	The overgrown lane to the right leads northward to an abandoned gravel pit that was operated in the Valmeyeran (middle Mississippian) Fort Payne Formation. This formation, 270-615 feet thick, usually consists of dark gray to black, calcareous siltstone or silty limestone. However, in the area surrounding Hicks Dome, the formation has been completely leached by weathering so that it consists mainly of chert beds up to one foot thick, with thin clay interlayers. (Slumping and plant undergrowth now obscure much of the formation.) Most of the chert probably was used for roadstone. Some of the chert is porous and relatively soft, commonly called "cotton rock," and was sold as chicken litter.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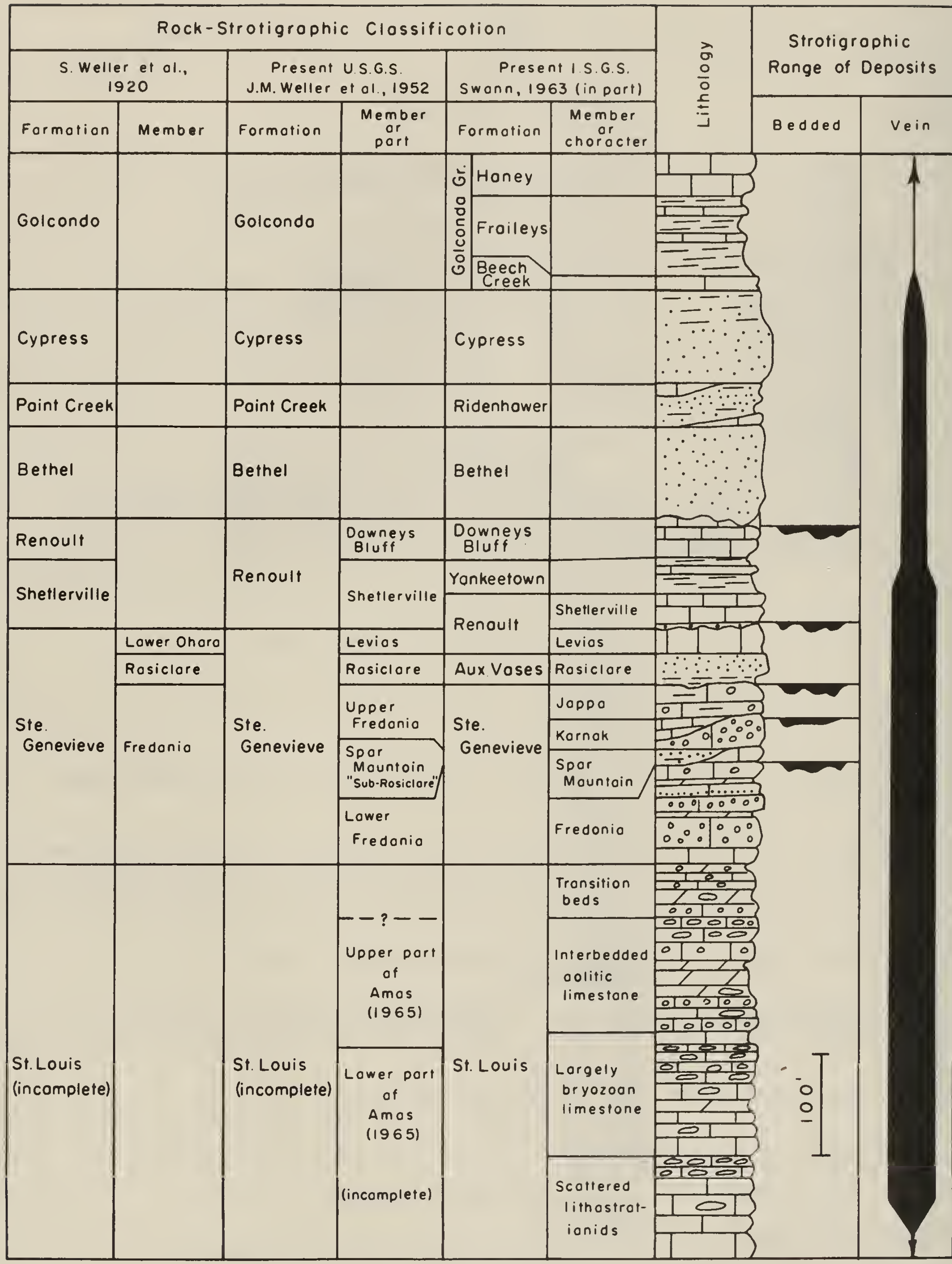
Miles to next point	Miles to starting point	
0.2+	28.55	Upper Devonian New Albany Shale Group is exposed in road bank to right.
0.1	28.65	Y-intersection; CONTINUE AHEAD (northwesterly).
0.4+	29.05	CURVE LEFT (west).
0.05	29.1+	CAUTION; concrete ford across Goose Creek. CONTINUE AHEAD (west); the hill ahead is the central part of Hicks Dome.
0.05	28.15+	CURVE RIGHT (northwesterly).
0.65	29.8+	STOP 7. DISCUSSION OF HICKS DOME FROM THE ROAD-WAY. CAUTION—ABUNDANT POISON IVY ALONG THE ROADSIDE.
0.0	29.8+	Leave Stop 7. CONTINUE AHEAD (northwest).
0.5	30.3+	T-road from right; CONTINUE AHEAD STRAIGHT (northwest and then north).
0.3	30.6+	T-road from left; TURN LEFT (westerly) downhill at the community of Hicks.
0.35+	30.95+	Y-intersection; BEAR LEFT (downhill). The route is now along the northwestern side of the central part of Hicks Dome. Dark gray to black shales of the upper Devonian New Albany Group underlie the route here.
0.4+	31.35+	CAUTION; concrete ford at Hicks Branch.
0.05	31.4+	CAUTION; concrete ford.
0.2-	31.6	T-road intersection; TURN RIGHT (west).
0.1	31.7-	CAUTION; rough concrete ford. The route generally is to the southwest toward SR 34.
0.1+	31.8+	CURVE LEFT (south); route crosses Valmeyeran (middle Mississippian) Fort Payne Formation and underlying Springville Shale strata.
0.55	32.35+	CAUTION; concrete ford at Hicks Branch.
0.05	32.4+	To the right in Hicks Branch are steeply dipping limestone beds of the Fort Payne Formation.

Miles to next point	Miles to starting point	
0.1	32.5+	T-road from left; CONTINUE AHEAD STRAIGHT and then BEAR RIGHT (northwesterly).
0.4-	32.9	STOP (2-way); crossroads. TURN LEFT (south) on SR 34. The route here is underlain by the Valmeyeran (middle Mississippian) Salem Limestone Formation.
0.85	33.75	Cross Buck Creek.
0.1	33.85	For the next 0.65 miles the route crosses Valmeyeran St. Louis Limestone strata.
0.65+	34.5+	The route crosses a large fault which brings Valmeyeran Ste. Genevieve strata to the surface for the next 1.15+ miles.
0.8-	35.3	CAUTION; enter hamlet of Eichorn.
0.4+	35.7+	Sandstone exposed here is the Valmeyeran Aux Vases Sandstone Formation.
0.1	35.8+	Leave Eichorn.
0.15	35.95+	Fossiliferous strata of the Chesterian (upper Mississippian) Shetlerville Member (Renault Limestone Formation) and the overlying Yankeetown Shale Formation occur for the next 0.1 mile.
0.55	36.5+	Chesterian Bethel Sandstone exposed to right. To the left and south for 0.25 miles are five abandoned fluorspar mine shaft sites along the north northwest side of a mineralized fault zone.
0.35	36.85+	The route has crossed the juncture of a fault complex and again lies across Valmeyeran Aux Vases Sandstone. To the right of SR 34 is an abandoned fluorite mine shaft site. Eight abandoned mine shafts occur along that fault trace within the next 0.6 miles to the south southwest.
0.7	37.55+	Prepare to CURVE LEFT at Y-intersection.
0.1-	37.65	CURVE LEFT (southeast) on SR 34.
0.1-	37.75-	STOP (2-way); Humm Wye. TURN HARD RIGHT (west) on SR 146. Prepare to turn left.

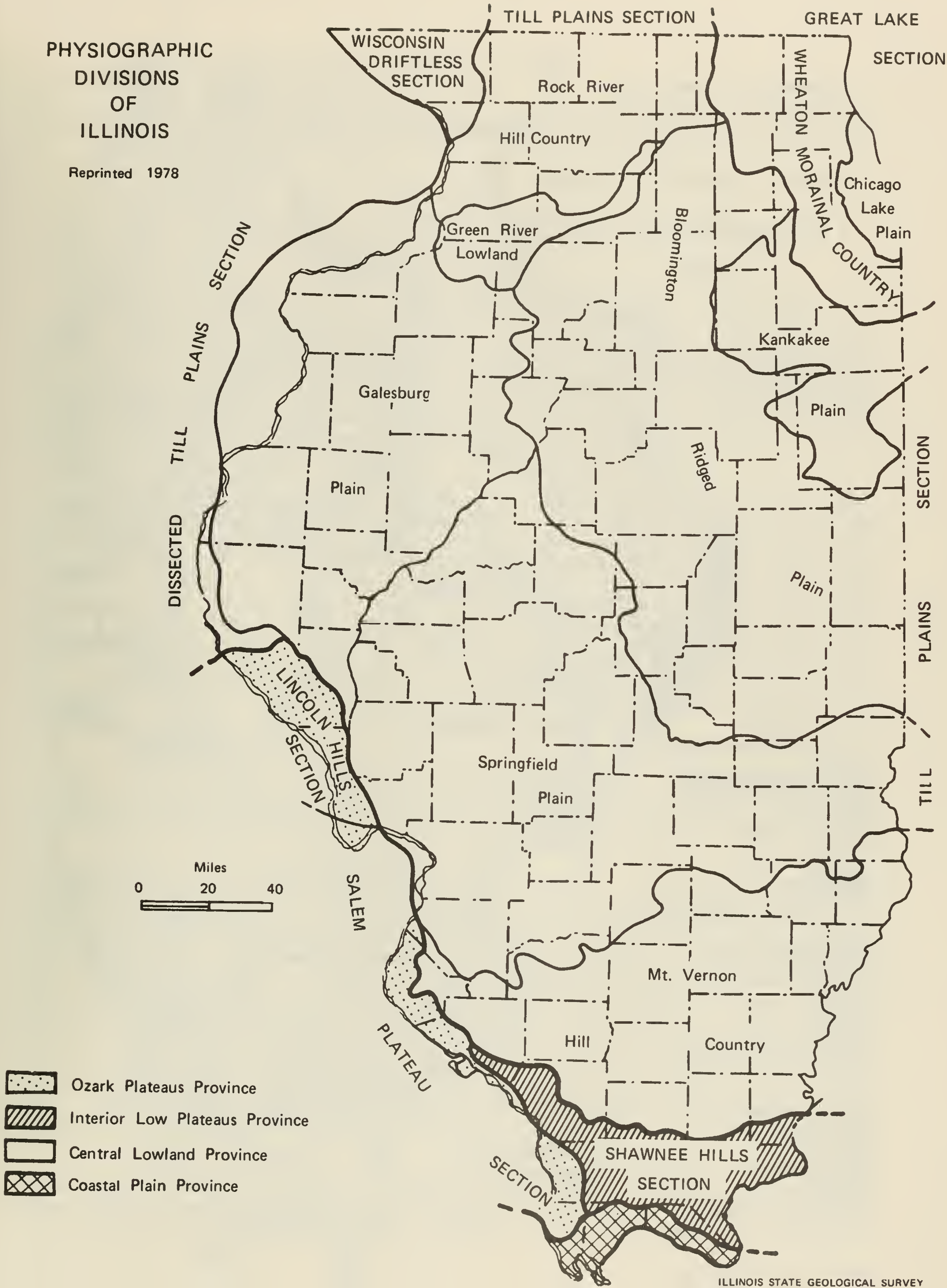
Miles to next point	Miles to starting point	
0.05+	37.8	CAUTION; T-road from left. TURN LEFT (south). Route underlain by Aux Vases Sandstone for next 0.95 miles. CAUTION; heavy coal truck traffic.
0.95-	38.75-	Route underlain by Valmeyeran Levias Member of the Renault Formation for approximately the next 0.35 miles.
0.35	39.1-	Route underlain by strata of the Chesterian Shetlerville Member of the Renault Formation, the overlying Yankeetown Shale Formation, and the Downeys Bluff Limestone Formation for the next 0.6 miles.
0.75+	39.85	TURN RIGHT (west) and prepare to stop.
0.15	40.0	Park along right (north) side of blacktop road. USE EXTREME CAUTION; heavy, fast traffic here.
		STOP 8. FOSSIL COLLECTING SITE AND DISCUSSION OF CHESTERIAN (UPPER MISSISSIPPIAN) YANKEETOWN SHALE FORMATION. EXPOSURE IS ABOUT 100 FEET SOUTH OF THE ROAD. DO NOT CLIMB ON THE ROCK PILES TO THE SOUTH NOR GO DOWN THE CREEK TO COLLECT AS THIS IS PRIVATE PROPERTY.
		END OF TRIP
		NOTE: A museum containing a number of excellent specimens of fluorite and associated minerals is located in Rosiclare, about 8 miles from Stop 8 via SR 34. Pictures and mining equipment are also on display.

SYSTEM	SERIES	FORMATION	MEMBER	LITHOLOGY	THICKNESS (FT.)	LITHOLOGIC DESCRIPTION
PENNSYLVANIAN					600-900	Sandstone, shale, thin coals
MISSISSIPPIAN	CHESTERIAN	KINKAID			0 - 80	Gray, cherty limestone; shale
		DEGONIA			0 - 30	Shale and thin-bedded sandstone
		CLORE			100-120	Shale; limestone; thin-bedded sandstone
		PALESTINE			50 - 60	Sandstone, silty shale
		MENARD			100-130	Fine-grained limestone; shale
		WALTERSBURG			15 - 50	Shale; shaly sandstone
		VIENNA			10 - 20	Limestone; shaly limestone
		TAR SPRINGS			90 - 110	Sandstone; shale; thin coal
		GLEN DEAN			40 - 70	Fossiliferous, partly oolitic limestone; shale
		HARDINSBURG			90 - 115	Sandstone; shale
		HANEY			105-140	Fossiliferous limestone
		FRAILEYS				Shale; thin limestone
		BEECH CREEK				Silty limestone
		CYPRESS			80-110	Sandstone; shale
		RIDENHOWER			25 - 65	Shale; shaly sandstone
		BETHEL			80-100	Sandstone
		DOWNEYS BLUFF			25 - 40	Crinoidal, locally oolitic limestone
		YANKEETOWN			30 - 45	Shale; siltstone (Yankeetown); limestone; shale (Shetlerville)
	VALMEYERAN	RENAULT	Shetlerville		15 - 35	Light-colored oolitic limestone (Levias)
			Levias			
		AUX VASES	Rosiclare		15 - 35	Calcareous sandstone, shale at base
		STE. GENEVIEVE	Spar Mtn.		120-160	Light-colored, largely oolitic limestone; sandstone lenses
		ST. LOUIS			350-400	Fine-grained, cherty limestone
		SALEM			500±	Dark-colored, fine-grained limestone; foraminiferal calcarenite
		ULLIN			125-360	Crinoidal, bryozoan limestone; dark-gray, fine-grained limestone
		FORT PAYNE			225-640	Siltstone; silty, cherty limestone
DEVONIAN-MISSISSIPPIAN		SPRINGVILLE				Gray and greenish gray shale
		NEW ALBANY GROUP			395±	Gray to black shale
DEVONIAN		LINGLE			250±	Limestone and chert
		GRAND TOWER				
		CLEAR CREEK				

Stratigraphic column of exposed Paleozoic formations, Illinois-Kentucky fluorspar district (from ISGS Guidebook Series 11, 1973).



Lower Chesterian and upper Valmeyeran strata of the Illinois-Kentucky fluorspar district showing range of deposits (from ISGS Guidebook Series 11, 1973).


PHYSIOGRAPHIC
DIVISIONS
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ILLINOIS
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TILL PLAINS SECTION
GREAT LAKE
SECTION
WISCONSIN
DRIFTLESS
SECTION
Rock River
Hill Country
WHEATON MORAINAL COUNTRY
Chicago
Lake
Plain
Green River
Lowland
Bloomington
Kankakee
Plain
Galesburg
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DISSECTED TILL PLAINS SECTION
SECTION
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LINCOLN HILLS
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Springfield
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SALEM
PLATEAU
SECTION
Mt. Vernon
Hill
Country
SHAWNEE HILLS
SECTION
Ozark Plateaus Province
Interior Low Plateaus Province
Central Lowland Province
Coastal Plain Province
ILLINOIS STATE GEOLOGICAL SURVEY

ILLINOIS STATE GEOLOGICAL SURVEY

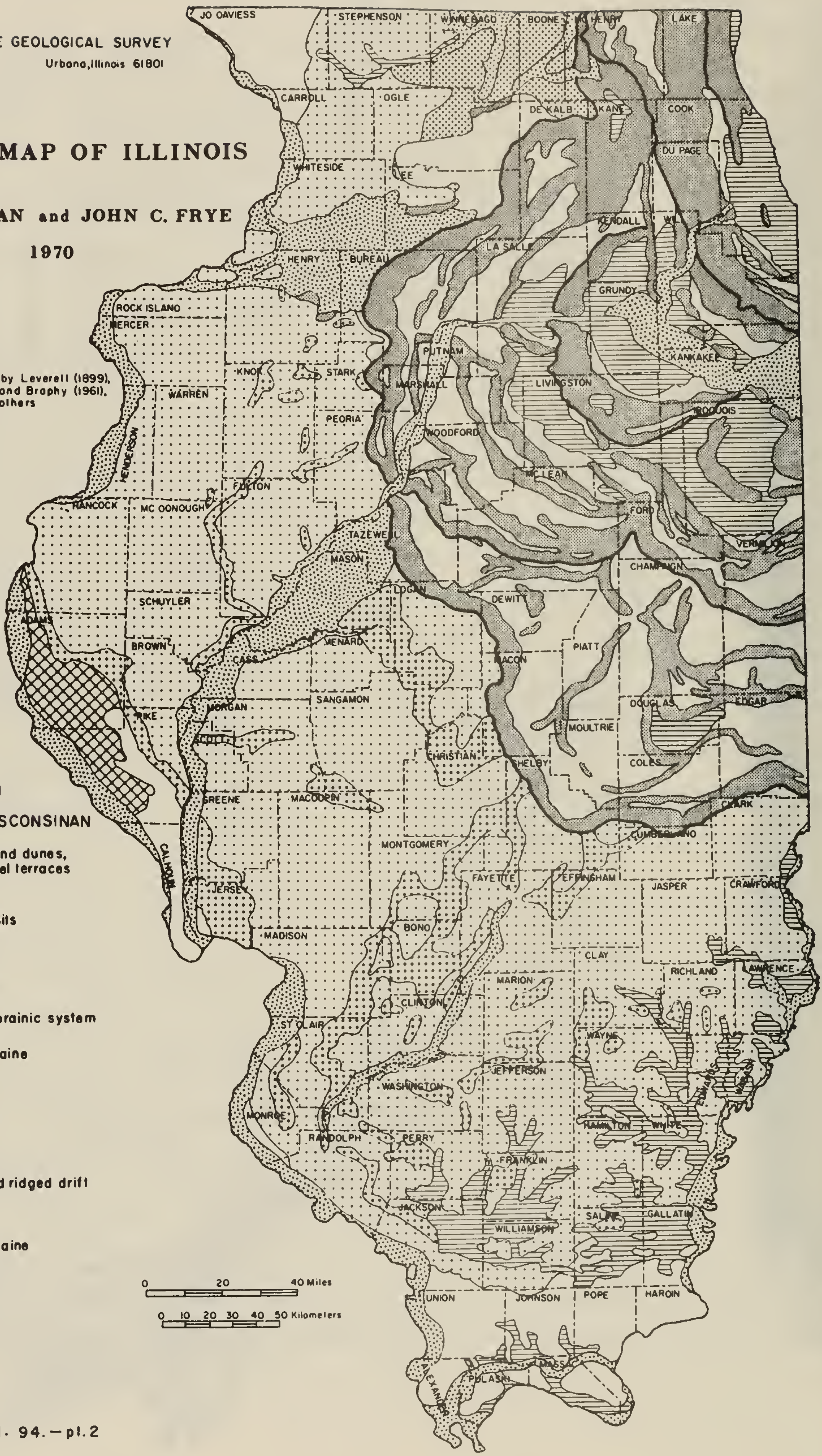
John C. Frye, Chief   Urbana, Illinois 61801

GLACIAL MAP OF ILLINOIS

H.B. WILLMAN and JOHN C. FRYE

1970

Modified from maps by Leverett (1899), Ekblow (1959), Leighton and Brophy (1961), Willman et al. (1967), and others



EXPLANATION

HOLOCENE AND WISCONSINAN

Alluvium, sand dunes, and gravel terraces

WISCONSINAN

Lake deposits

WOODFORDIAN

Moraine

Front of morainic system

Groundmoraine

ALTONIAN

Till plain

ILLINOIAN

Moraine and ridged drift

Groundmoraine

KANSAN

Till plain

DRIFTLESS

Modified from Bull. 94.—pl. 2

ILLINOIS STATE GEOLOGICAL SURVEY
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ANCIENT DUST STORMS IN ILLINOIS

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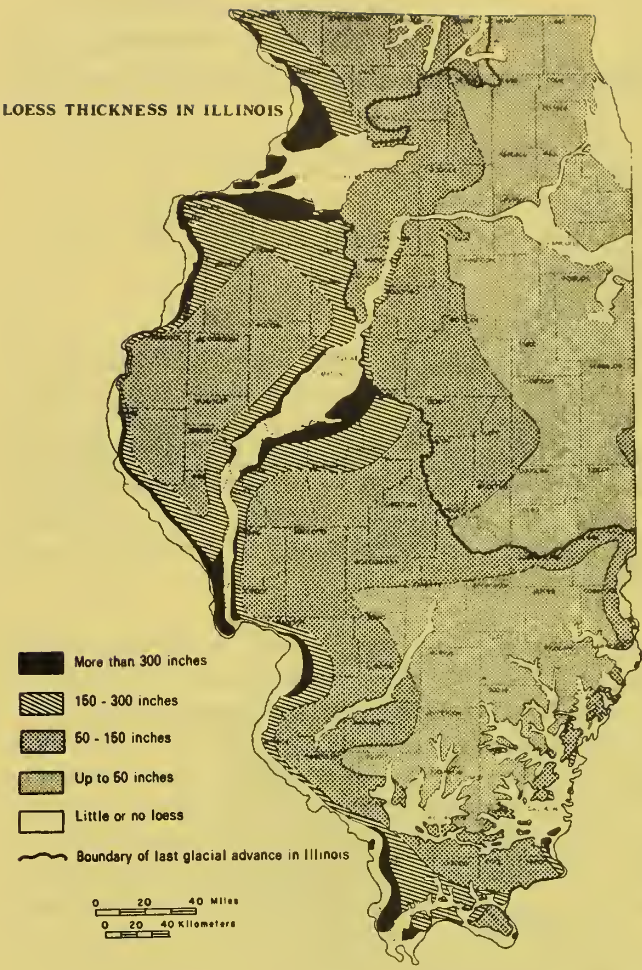
Fierce dust storms whirled across Illinois long before human beings were here to record them. Where did all the dust come from? Geologists have carefully put together clues from the earth itself to get the story. As the glaciers of the Great Ice Age scraped and scoured their way southward across the landscape from Canada, they moved colossal amounts of rock and earth. Much of the rock ground from the surface was kneaded into the ice and carried along, often for hundreds of miles. The glaciers acted as giant grist mills, grinding much of the rock and earth to "flour"—very fine dust-sized particles.

During the warm seasons, water from the melting ice poured from the glacier front, laden with this rock flour, called silt. In the cold months the meltwater stopped flowing and the silt was left along the channels the water had followed, where it dried out and became dust. Strong winds picked up the dust, swept it from the floodplains, and carried it to adjacent uplands. There the forests along the river valleys trapped the dust, which became part of the moist forest soil. With each storm more material accumulated until the high bluffs adjacent to major rivers were formed. The dust deposits are thicker along the eastern sides of the valleys than they are on the western sides, a fact from which geologists deduce that the prevailing winds of that time blew from west to east, the same direction as those of today. From such clues geologists conclude that the geologic processes of the past were much like those of today.

The deposits of windblown silt are called loess (rhymes with "bus"). Loess is found not only in the areas once covered by the glaciers but has been blown into the nonglaciated areas. The glaciers, therefore, influenced the present land surface well beyond the line of their farthest advance.

Loess has several interesting characteristics. Its texture is so fine and uniform that it can easily be identified in roadcuts—and because it blankets such a vast area many roads are cut through it. Even more noticeable is its tendency to stand in vertical walls. These steep walls develop as the loess drains and becomes tough, compact, and massive, much like a rock. Sometimes cracks develop in the loess, just as they do in massive limestones and sandstones. Loess makes good highway banks if it is cut vertically. A vertical cut permits maximum drainage because little surface is exposed to rain, and rainwater tends to drain straight down through it to the rock underneath. If the bank is cut at an angle more water soaks in, which causes the loess to slump down. Along Illinois roads the difference between a loess roadcut and one in ordinary glacial till is obvious. The loess has a very uniform texture, while the till is composed of a random mixture of rock debris, from clay and silt through cobbles and boulders.

Many loess deposits are worth a close look. Through a 10-power hand lens separate grains can be seen, among them many clear, glassy, quartz grains. Some loess deposits contain numerous rounded, lumpy stones called concretions. Their formation began when water percolating through the loess dissolved tiny



limestone grains. Some of the dissolved minerals later became solid again, gathering around a tiny nucleus or along roots to form the lumpy masses. A few such concretions are shaped roughly like small dolls and, from this resemblance, are called "loess kindchen," a German term meaning "loess children." They may be partly hollow and contain smaller lumps that make them rattle when shaken.

Fossil snails can be found in some loess deposits. The snails lived on the river bluffs while the loess was being deposited and were buried by the dust. When they are abundant, they are used to determine how old the loess is. The age is found by measuring the amount of radioactive carbon in the calcium carbonate of their shells.

Some of the early loess deposits were covered by new layers of loess following later glacial invasions. Many thousands of years passed between the major glacial periods, during which time the climate was as warm as that of today. During the warm intervals, the surface of the loess and other glacial deposits was exposed to weather. Soils developed on most of the terrain, altering the composition, color, and texture of the glacial material. During later advances of the ice, some of these soils were destroyed, but in many places they are preserved under the younger sediments. Such ancient buried soils can be used to determine when the materials above and below them were laid down by the ice and what changes in climate took place.

The blanket of loess deposited by the ancient dust storms forms the parent material of the rich, deep soils that today are basic to the state's agriculture. A soil made of loess crumbles easily and has great moisture-holding capacity. It also is free from rocks that might complicate cultivation. Those great dust storms that swirled over the land many thousands of years ago thus endowed Illinois with one of its greatest resources, its highly productive soil.

DEPOSITIONAL HISTORY OF THE PENNSYLVANIAN ROCKS

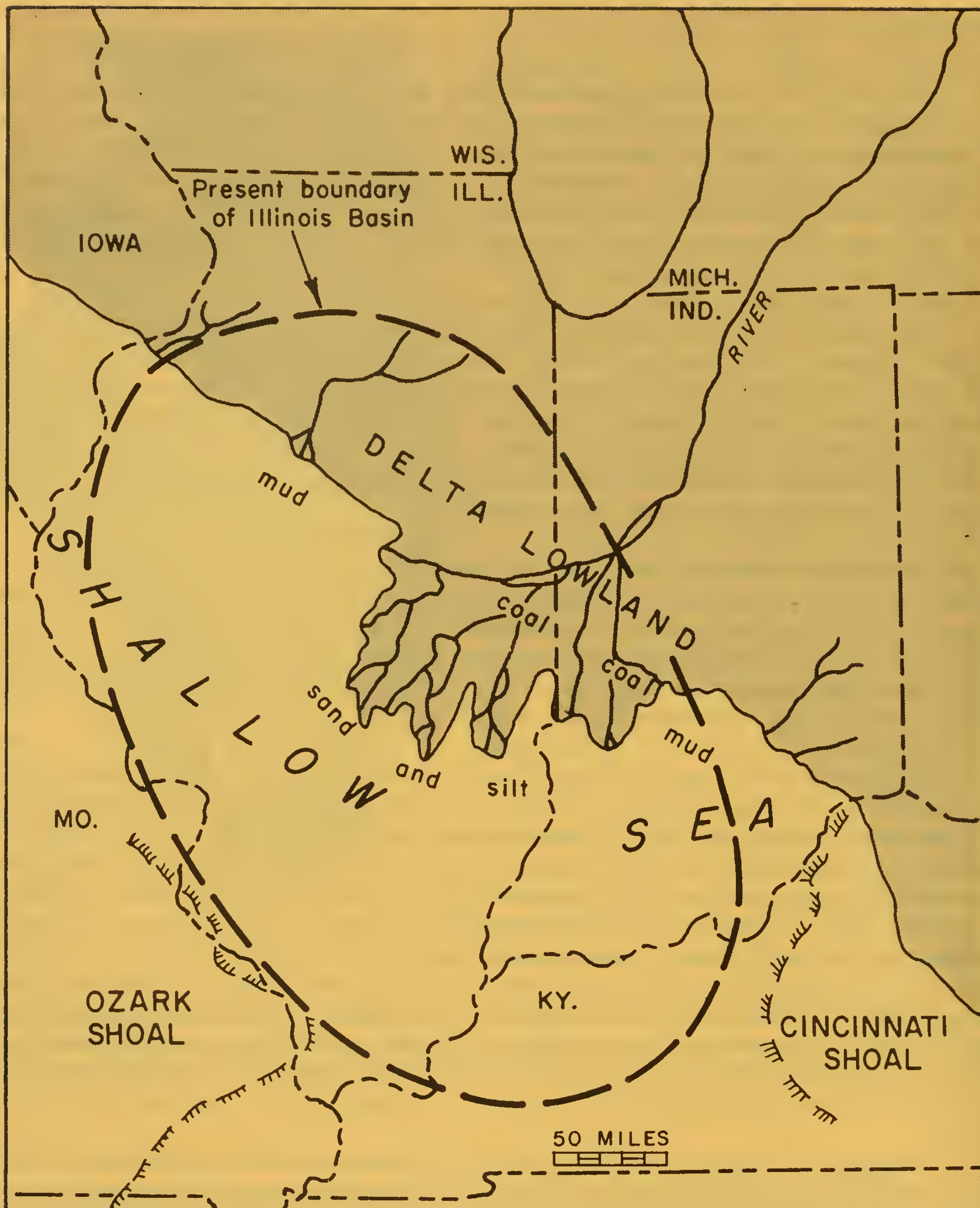
At the close of the Mississippian Period, about 310 million years ago, the Mississippian sea withdrew from the Midcontinent region. A long interval of erosion took place early in Pennsylvanian time and removed hundreds of feet of the pre-Pennsylvanian strata, completely stripping them away and cutting into older rocks over large areas of the Midwest. An ancient river system cut deep channels into the bedrock surface. Erosion was interrupted by the invasion of the Morrowan (early Pennsylvanian) sea.

Depositional conditions in the Illinois Basin during the Pennsylvanian Period were somewhat similar to those that existed during Chesterian (late Mississippian) time. A river system flowed southwestward across a swampy lowland, carrying mud and sand from highlands in the northeast. A great delta was built out into the shallow sea (see paleogeography map on next page). As the lowland stood only a few feet above sea level, only slight changes in relative sea level caused great shifts in the position of the shoreline.

Throughout Pennsylvanian time the Illinois Basin continued to subside while the delta front shifted owing to worldwide sea level changes, intermittent subsidence of the basin, and variations in the amounts of sediment carried seaward from the land. These alternations between marine and nonmarine conditions were more frequent than those during pre-Pennsylvanian time, and they produced striking lithologic variations in the Pennsylvanian rocks.

Conditions at various places on the shallow sea floor favored the deposition of sandstone, limestone, or shale. Sandstone was deposited near the mouths of distributary channels. These sands were reworked by waves and spread as thin sheets near the shore. The shales were deposited in quiet-water areas—in delta bays between distributaries, in lagoons behind barrier bars, and in deeper water beyond the nearshore zone of sand deposition. Most sediments now recognized as limestones, which are formed from the accumulation of limey parts of plants and animals, were laid down in areas where only minor amounts of sand and mud were being deposited. Therefore, the areas of sandstone, shale, and limestone deposition continually changed as the position of the shoreline changed and as the delta distributaries extended seaward or shifted their positions laterally along the shore.

Nonmarine sandstones, shales, and limestones were deposited on the deltaic lowland bordering the sea. The nonmarine sandstones were deposited in distributary channels, in river channels, and on the broad floodplains of the rivers. Some sand bodies, 100 or more feet thick, were deposited in channels that cut through many of the underlying rock units. The shales were deposited mainly on floodplains. Freshwater limestones and some shales were deposited locally in fresh-water lakes and swamps. The coals were formed by the accumulation of plant material, usually where it grew, beneath the quiet waters of extensive swamps that prevailed for long intervals on the emergent delta lowland. Lush forest vegetation, which thrived in the warm, moist Pennsylvanian climate, covered the region. The origin of the underclays beneath the coals is not precisely known, but they were probably deposited in the swamps as slackwater muds before the formation of the coals. Many underclays contain plant roots and rootlets that appear to be in their original places. The formation of coal marked the end of the nonmarine portion of the depositional cycle, for resubmergence of the borderlands by the sea interrupted nonmarine deposition, and marine sediments were then laid down over the coal.



Paleogeography of Illinois-Indiana region during Pennsylvanian time. The diagram shows the Pennsylvanian river delta and the position of the shoreline and the sea at an instant of time during the Pennsylvanian Period.

Pennsylvanian Cyclothems

Because of the extremely varied environmental conditions under which they formed, the Pennsylvanian strata exhibit extraordinary variations in thickness and composition, both laterally and vertically. Individual sedimentary units are often only a few inches thick and rarely exceed 30 feet thick. Sandstones and shales commonly grade laterally into each other, and shales sometimes interfinger and grade into limestones and coals. The underclays, coals, black shales, and

limestones, however, display remarkable lateral continuity for such thin units (usually only a few feet thick). Coal seams have been traced in mines, outcrops, and subsurface drill records over areas comprising several states.

The rapid and frequent changes in depositional environments during Pennsylvanian time produced regular or cyclical alternations of sandstone, shale, limestone, and coal in response to the shifting front of the delta lowland. Each series of alternations, called a cyclothem, consists of several marine and nonmarine rock units that record a complete cycle of marine invasion and retreat. Geologists have determined, after extensive studies of the Pennsylvanian strata in the Midwest, that an ideally complete cyclothem consists of 10 sedimentary units. The chart on the next page shows the arrangement. Approximately 50 cyclothems have been described in the Illinois Basin, but only a few contain all 10 units. Usually one or more are missing because conditions of deposition were more varied than indicated by the ideal cyclothem. However, the order of units in each cyclothem is almost always the same. A typical cyclothem includes a basal sandstone overlain by an underclay, coal, black sheety shale, marine limestone, and gray marine shale. In general, the sandstone-underclay-coal portion (the lower 5 units) of each cyclothem is nonmarine and was deposited on the coastal lowlands from which the sea had withdrawn. However, some of the sandstones are entirely or partly marine. The units above the coal are marine sediments and were deposited when the sea advanced over the delta lowland.

Origin of Coal

It is generally accepted that the Pennsylvanian coals originated by the accumulation of vegetable matter, usually in place, beneath the waters of extensive, shallow, fresh-to-brackish swamps. They represent the last-formed deposits of the nonmarine portions of the cyclothems. The swamps occupied vast areas of the deltaic coastal lowland, which bordered the shallow Pennsylvanian sea. A luxuriant growth of forest plants, many quite different from the plants of today, flourished in the warm Pennsylvanian climate. Today's common deciduous trees were not present, and the flowering plants had not yet evolved. Instead, the junglelike forests were dominated by giant ancestors of present-day club mosses, horsetails, ferns, conifers, and cycads. The undergrowth also was well developed, consisting of many ferns, fernlike plants, and small club mosses. Most of the plant fossils found in the coals and associated sedimentary rocks show no annual growth rings, suggesting rapid growth rates and lack of seasonal variations in the climate. Many of the Pennsylvanian plants, such as the seed ferns, eventually became extinct.

Plant debris from the rapidly growing swamp forests—leaves, twigs, branches, and logs—accumulated as thick mats of peat on the floors of the swamps. Normally, vegetable matter rapidly decays by oxidation, forming water, nitrogen, and carbon dioxide. However, the cover of swamp water, which was probably stagnant and low in oxygen, prevented the complete oxidation and decay of the peat deposits.

The periodic invasions of the Pennsylvanian sea across the coastal swamps killed the Pennsylvanian forests and initiated marine conditions of deposition. The peat deposits were buried by marine sediments. Following burial, the peat deposits were gradually transformed into coal by slow chemical and physical changes in which pressure (compaction by the enormous weight of overlying sedimentary layers), heat (also due to deep burial), and time were the most important factors. Water and volatile substances (nitrogen, hydrogen, and oxygen) were slowly driven off during the coalification process, and the peat deposits were changed into coal.

Coals have been classified by ranks that are based on the degree of coalification. The commonly recognized coals, in order of increasing rank, are (1) brown coal or lignite, (2) sub-bituminous, (3) bituminous, (4) semibituminous, (5) semianthracite, and (6) anthracite. Each increase in rank is characterized by larger amounts of fixed carbon and smaller amounts of oxygen and other volatiles. Hardness of coal also increases with increasing rank. All Illinois coals are classified as bituminous.

Underclays occur beneath most of the coals in Illinois. Because underclays are generally unstratified (unlayered), are leached to a bleached appearance, and generally contain plant roots, many geologists consider that they represent the ancient soils on which the coal-forming plants grew.

The exact origin of the carbonaceous black shales that occur above many coals is uncertain. The black shales probably are deposits formed under restricted marine (lagoonal) conditions during the initial part of the invasion cycle, when the region was partially closed off from the open sea. In any case, they were deposited in quiet-water areas where very fine, iron-rich muds and finely divided plant debris were washed in from the land. The high organic content of the black shales is also in part due to the carbonaceous remains of plants and animals that lived in the lagoons. Most of the fossils represent planktonic (floating) and nektonic (swimming) forms—not benthonic (bottom dwelling) forms. The depauperate (dwarf) fossil forms sometimes found in black shales formerly were thought to have been forms that were stunted by toxic conditions in the sulfide-rich, oxygen-deficient waters of the lagoons. However, study has shown that the "depauperate" fauna consists mostly of normal-size individuals of species that never grew any larger.

10 Shale, gray, sandy at top; contains marine fossils and ironstone concretions, especially in lower part.

9 Limestone; contains marine fossils.

8 Shale, black, hard, laminated; contains large spheroidal concretions and marine fossils.

7 Limestone; contains marine fossils.

6 Shale, gray; pyritic nodules and ironstone concretions common at base; plant fossils locally common at base; marine fossils rare.

5 Coal; locally contains clay or shale partings.

4 Underclay, mostly medium to light gray but dark gray at top; upper part noncalcareous, lower part calcareous.

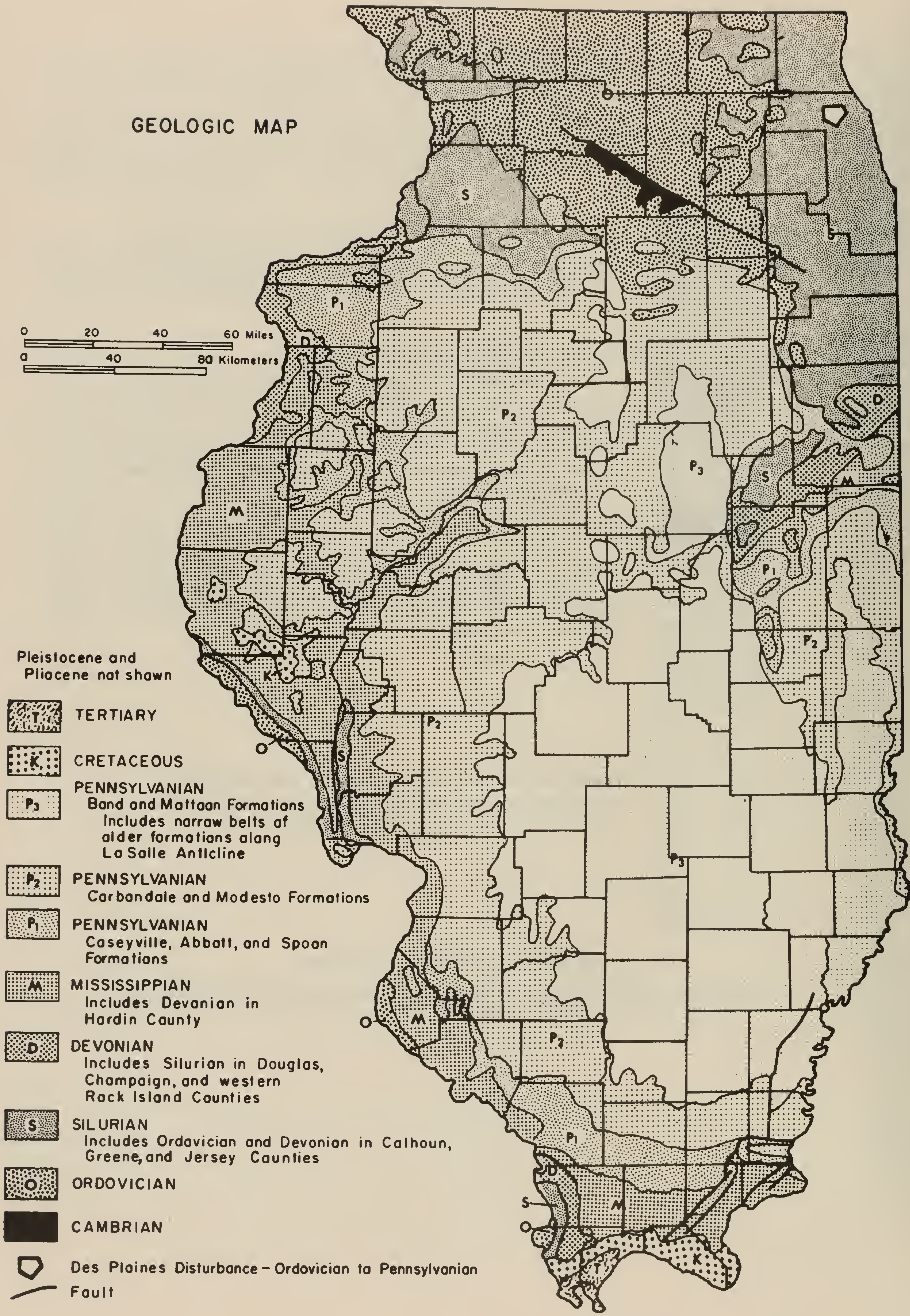
3 Limestone, argillaceous; occurs in nodules or discontinuous beds; usually nonfossiliferous.

2 Shale, gray, sandy.

1 Sandstone, fine grained, micaceous, and siltstone, argillaceous; varies from massive to thin bedded; usually has an uneven lower surface.

AN IDEALLY COMPLETE CYCLOTHEM

(Reprinted from Fig. 42, Bulletin No. 66, Geology and Mineral Resources of the Marseilles, Ottawa, and Streator Quadrangles, by H. B. Willman and J. Norman Payne)


GEOLOGIC MAP
0 20 40 60 Miles
0 40 80 Kilometers
Pleistocene and Pliocene not shown
TERTIARY
CRETACEOUS
PENNSYLVANIAN
Bond and Mattoon Formations
Includes narrow belts of older formations along La Salle Anticline
PENNSYLVANIAN
Carbondale and Modesto Formations
PENNSYLVANIAN
Caseyville, Abbott, and Spoon Formations
MISSISSIPPIAN
Includes Devonian in Hardin County
DEVONIAN
Includes Silurian in Douglas, Champaign, and western Rock Island Counties
SILURIAN
Includes Ordovician and Devonian in Calhoun, Greene, and Jersey Counties
ORDOVICIAN
CAMBRIAN
Des Plaines Disturbance - Ordovician to Pennsylvanian
Fault

MISSISSIPPIAN DEPOSITION

(The following quotation is from Report of Investigations 216: Classification of Genevievian and Chesterian...Rocks of Illinois [1965] by D. H. Swann, pp. 11-16. One figure and short sections of the text are omitted.)

During the Mississippian Period, the Illinois Basin was a slowly subsiding region with a vague north-south structural axis. It was flanked by structurally neutral regions to the east and west, corresponding to the present Cincinnati and Ozark Arches. These neighboring elements contributed insignificant amounts of sediment to the basin. Instead, the basin was filled by locally precipitated carbonate and by mud and sand eroded from highland areas far to the northeast in the eastern part of the Canadian Shield and perhaps the northeastward extension of the Appalachians. This sediment was brought to the Illinois region by a major river system, which it will be convenient to call the Michigan River (fig. 4) because it crossed the present state of Michigan from north to south or northeast to southwest....

The Michigan River delivered much sediment to the Illinois region during early Mississippian time. However, an advance of the sea midway in the Mississippian Period prevented sand and mud from reaching the area during deposition of the St. Louis Limestone. Genevievian time began with the lowering of sea level and the alternating deposition of shallow-water carbonate and clastic units in a pattern that persisted throughout the rest of the Mississippian. About a fourth of the fill of the basin during the late Mississippian was carbonate, another fourth was sand, and the remainder was mud carried down by the Michigan River.

Thickness, facies, and crossbedding...indicate the existence of a regional slope to the southwest, perpendicular to the prevailing north 65° west trend of the shorelines. The Illinois Basin, although developing structurally during this time, was not an embayment of the interior sea. Indeed, the mouth of the Michigan River generally extended out into the sea as a bird-foot delta, and the shoreline across the basin area may have been convex more often than concave.

....The shoreline was not static. Its position oscillated through a range of perhaps 600 to 1000 or more miles. At times it was so far south that land conditions existed throughout the present area of the Illinois Basin. At other times it was so far north that there is no suggestion of near-shore environment in the sediments still preserved. This migration of the shoreline and of the accompanying sedimentation belts determined the composition and position of Genevievian and Chesterian rock bodies.

Lateral shifts in the course of the Michigan River also influenced the placement of the rock bodies. At times the river brought its load of sediment to the eastern edge of the basin, at times to the center, and at times to the western edge. This lateral shifting occurred within a range of about 200 miles. The Cincinnati and Ozark areas did not themselves provide sediments, but, rather, the Michigan River tended to avoid those relatively positive areas in favor of the down-warped basin axis.

Sedimentation belts during this time were not symmetrical with respect to the mouth of the Michigan River. They were distorted by the position of the river relative to the Ozark and Cincinnati shoal areas, but of greater importance was sea current or drift to the northwest. This carried off most of the mud contributed by the river, narrowing the shale belt east of the river mouth and broadening it west

of the mouth. Facies and isopach maps of individual units show several times as much shale west of the locus of sand deposition as east of it. The facies maps of the entire Chesterian...show maximum sandstone deposition in a northeast-southwest belt that bisects the basin. The total thickness of limestone is greatest along the southern border of the basin and is relatively constant along that entire border. The proportion of limestone, however, is much higher at the eastern end than along the rest of the southern border, because little mud was carried southeastward against the prevailing sea current. Instead, the mud was carried to the northwest and the highest proportion of shale is found in the northwestern part of the basin.

Genevievian and Chesterian seas generally extended from the Illinois Basin eastward across the Cincinnati Shoal area and the Appalachian Basin. Little terrigeneous sediment reached the Cincinnati Shoal area from either the west or the east, and the section consists of thin limestone units representing all or most of the major cycles. The proportion of inorganically precipitated limestone is relatively high and the waters over the shoal area were commonly hypersaline... Erosion of the shoal area at times is indicated by the presence of conodonts eroded from the St. Louis Limestone and redeposited in the lower part of the Gasper Limestone at the southeast corner of the Illinois Basin...

The shoal area included regions somewhat east of the present Cincinnati axis and extended from Ohio, and probably southeastern Indiana, through central and east-central Kentucky and Tennessee into Alabama....

Toward the west, the seaway was commonly continuous between the Illinois Basin and central Iowa, although only the record of Genevievian and earliest Chesterian is still preserved. The seas generally extended from the Illinois and Black Warrior regions into the Arkansas Valley region, and the presence of Chesterian outliers high in the Ozarks indicates that at times the Ozark area was covered. Although the sea was continuous into the Ouachita region, detailed correlation of the Illinois sediments with the geosynclinal deposits of this area is difficult.

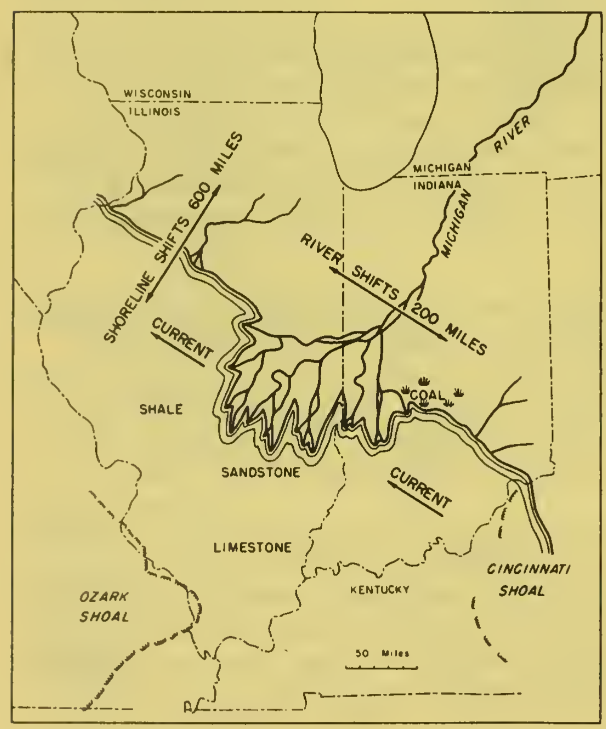
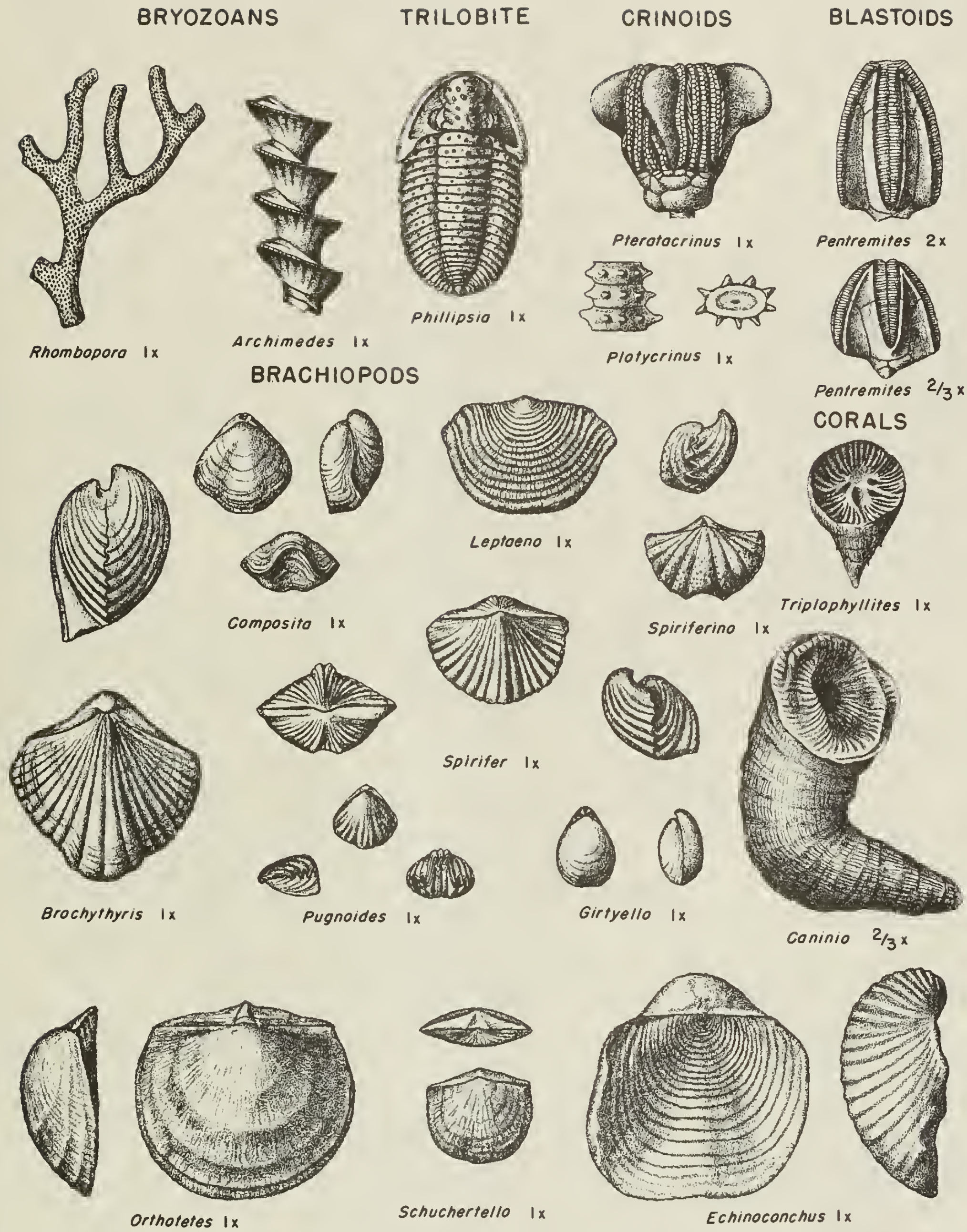
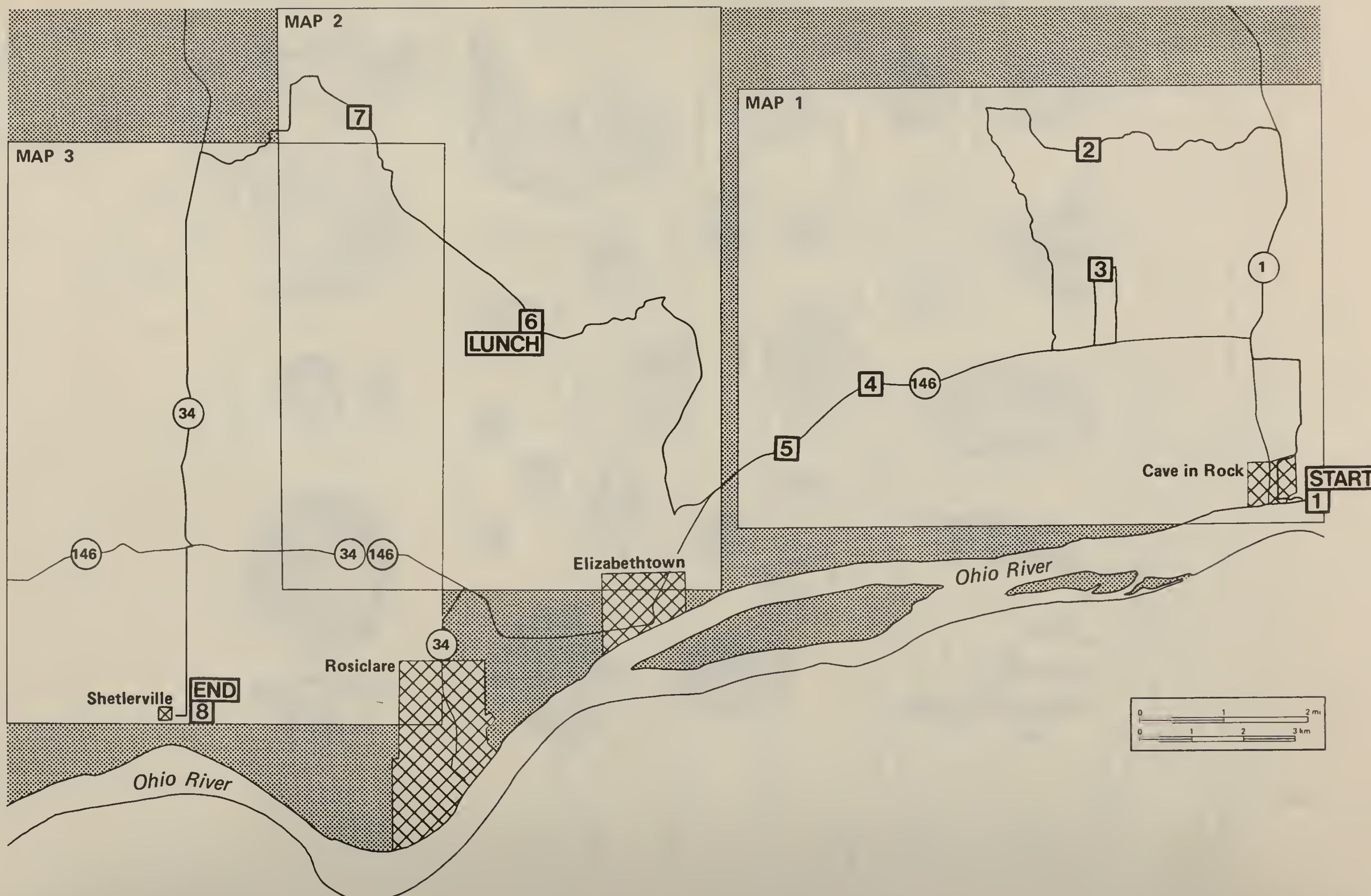


Figure 4: Paleogeography at an intermediate stage during Chesterian sedimentation.


BRYOZOANS
TRILOBITE
CRINOIDS
BLASTOIDS
Rhombopora 1x
Archimedes 1x
Phillipsia 1x
Pterotocrinus 1x
Pentremites 2x
Platycrinus 1x
Pentremites 2/3 x
BRACHIOPODS
CORALS
Leptaena 1x
Composita 1x
Triplophyllites 1x
Spiriferina 1x
Spirifer 1x
Brachythyris 1x
Pugnoides 1x
Girtyella 1x
Caninia 2/3 x
Orthotetes 1x
Schuchertella 1x
Echinoconchus 1x


MAP 1
MAP 2
MAP 3
START
1
2
3
4
5
6
LUNCH
7
END
8
Cave in Rock
Elizabethtown
Rosiclare
Shetlerville
Ohio River
Ohio River
1
146
34
146
34
146
34